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T-SPIL exploits threat missiles

GIVES OPTIONS TO DESIGNERS AND DEVELOPERS

Bad news—*Terry Dougherty and Dennis McKinney display SA-7 Strela and SA-16 Igla weapons potentially capable of downing any fixed- or rotary-wing aircraft in the U.S. inventory.*

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Countering Infrared Threat Missiles

"Know thine Enemy." At NAWCWD, delving into the inner mysteries of threat weaponry has always been a field of productive study. From the rudimentary analysis of German and Japanese weapons in the 1940s to the more ambitious foreign-material-exploitation efforts of the Cold War and beyond, China Lake and Point Mugu have often focused their technical skills on analyzing the strengths and weaknesses of foreign-developed technology.

The Threat Signal Processor In the Loop or T-SPIL, now completing development within the Integrated Battlespace Arena (IBAR), will continue this tradition by giving greater insight into the workings of threat IR missiles. These common antiaircraft weapons are growing in sophistication and complexity and, because of their low cost, are becoming more accessible to potential adversaries throughout the world. Fortunately, many of these threat missiles have been available for study through various DOD and other U.S. Government agencies.

An Electronic Trickster

T-SPIL is an electronic trickster. It pulls the wool over an IR missile's eye by injecting a false picture into the weapon's signal processing unit. This signal is "assumed" by the processing unit to be coming from the IR sensor/seeker as the missile searches for a target or maneuvers in chase of its prey. In fact, though, the information that arrives at the signal processing unit comes not from the seeker but from massive Silicon Graphics, Inc. (SGI) computers located in the IBAR's High-Performance Computing Center.

The beauty of this approach is the limitless range of options it gives to tactics developers, counter-measures designers, and even aircraft structural and materials engineers. Want to see, for example, how an SA-7 would operate when fired at a Stealth fighter in a head-on shot at 3000 meters? And on top of that, what the reaction of the missile would be when the aircraft dispensed a particular type of countermeasure? Gin up the scenario in the SGIs, feed it to the missile, and sit back and watch what happens.

IBAR Engagment Simulation Scenarios

Once the desired digital scenario is developed in the SGIs, it is sent to the T-SPIL's convolver—an item so unique that a Navy patent application has been submitted on it—and then converted to an analog signal. That analog signal is fed into the threat system's signal processing unit, a real piece of hardware from the missile. In response to the analog signal, the signal processng unit generates the command signals that the missile would fly by if the scenario were real.

These command signals can either be injected into further simulations of the weapon's aerodynamic control system or pumped straight into the missile's actual control hardware. "We can mix and match simulations and real hardware, depending on what is being studied," says Dennis McKinney, head of the EO/IR Systems Evaluation Office.

Test personnel watch on video monitors as the scenario unfolds. The cross-hairs of the reticle seeker drift back and forth across the scenario image, showing just how well—or how poorly—the missile performs as it attempts to kill the phantom target. Every output and function of the threat missile components is monitored and recorded for post-test analysis and archiving.

The real thing—*Surrounded by T-SPIL circuitry, power supplies and wiring, the signal processing unit of an SA-7, one of the world's most widely used surface-to-air missiles, undergoes testing.*

T-SPIL Development

T-SPIL is the product of a 4.0 Competency team directed by McKinney. He, Bruce Heydlauff, and John Channer invented the Real-Time Scene Convolver, the heart of the T-SPIL. Brian Ogilvie and Channer designed the hardware, and Sue Oah designed the printed circuit boards. Dave Brewton and Dianne Krotter assembled the complete system and circuit boards, and Randy Mather oversaw materials procurement. Terry Dougherty performed overall systems engineering for the T-SPIL development program.

For many years the need for a T-SPIL had been recognized. However the technology necessary to actually build one—particularly the high-speed digital signal processors, or DSPs—was not available until 1997. In 1998 McKinney's group put together a demonstration circuit with funding from the Office of the Test Director, an Office of the Secretary of Defense T&E Directorate based at White Sands, New Mexico.

During the remainder of 1999 and 2000, T-SPIL development will be funded by the Crossbow Committee, a tri-service activity that coordinates DOD threat simulations. McKinney's group will demonstrate the T-SPIL to the Committee with a target-tracking exercise in January 2000.

Future Development Plans

Looking ahead, the T-SPIL development team plans to increase the utility of their system. In 2000, they will incorporate a six-degree-of-freedom aerodynamic model into the overall simulation. This will allow the missile's flight path to be fed back into the SGI computers which in turn will change their inputs to the convolver, thus closing the guidance loop.

The next step will be introducing the man-in-the-loop element. Eventually, a pilot sitting in the cockpit of the IBAR's Virtual Prototyping Facility will be able to "fly" the virtual aircraft inside the SGI while a threat missile is launched. The VPF's highly realistic out-the-window display will show the reaction of the aircraft and missile as the pilot uses evasive tactics and countermeasures.

"We are building a revolutionary device here," McKinney emphasizes. "For the first time we will be able to accurately assess the response of threat hardware to any scenario we want to create in our supercomputers." The ultimate beneficiary of these efforts will be the operational forces. Weapons, tactics, countermeasures, and platforms developed with the benefit of T-SPIL threat assessments will help to ensure the continued technical preeminence of the U.S. warfighter.